US009439593B2

(12) **United States Patent**
Shepherd et al.

(10) **Patent No.: US 9,439,593 B2**
(45) **Date of Patent: *Sep. 13, 2016**

(54) **SYSTEM AND METHOD FOR DATA ANOMALY DETECTION PROCESS IN ASSESSMENTS**

(71) Applicant: **Questionmark Computing Limited**, London (GB)

(72) Inventors: **Eric Shepherd**, Miami Beach, FL (US); **John Kleeman**, London (GB)

(73) Assignee: **Questionmark Computing Limited**, London (GB)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 348 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **14/141,825**

(22) Filed: **Dec. 27, 2013**

(65) **Prior Publication Data**

US 2014/0114148 A1 Apr. 24, 2014

Related U.S. Application Data

(63) Continuation-in-part of application No. 13/667,425, filed on Nov. 2, 2012, now Pat. No. 8,816,861.

(60) Provisional application No. 61/873,443, filed on Sep. 4, 2013, provisional application No. 61/555,748, filed on Nov. 4, 2011.

(51) **Int. Cl.**

A61B 5/04	(2006.01)
A61B 5/16	(2006.01)
A61B 5/0476	(2006.01)
A61B 5/00	(2006.01)
A61B 5/0205	(2006.01)
A61B 5/053	(2006.01)

(52) **U.S. Cl.**

CPC ***A61B 5/168*** (2013.01); ***A61B 5/0476*** (2013.01); ***A61B 5/164*** (2013.01); *A61B 5/0022* (2013.01); *A61B 5/0205* (2013.01); *A61B 5/0533* (2013.01)

(58) **Field of Classification Search**

None

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,434,419	B1 *	8/2002	Gevins	A61B 5/0484 600/544
6,808,392	B1	10/2004	Walton	
7,565,193	B2	7/2009	Laken	
8,062,220	B2	11/2011	Kurtz et al.	
8,244,475	B2	8/2012	Aguilar et al.	

(Continued)

FOREIGN PATENT DOCUMENTS

WO	2012161657	A1	11/2012

OTHER PUBLICATIONS

International Search Report issued in PCT/US14/51853 on Nov. 6, 2014.

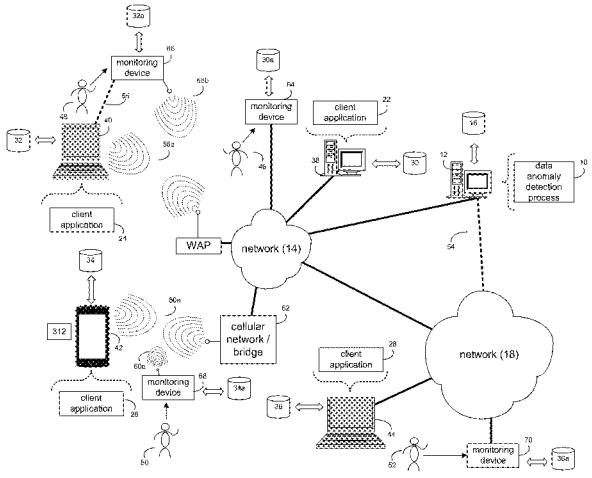
(Continued)

Primary Examiner — Brian T Gedeon
Assistant Examiner — Ankit D Tejani
(74) *Attorney, Agent, or Firm* — Brian J. Colandreo; Michael T. Abramson; Holland & Knight LLP

(57) **ABSTRACT**

A method, computer program product, and computer system for identifying at least one attribute of a user. An attention level of the user is determined with the identified at least one attribute. The attention level of the user is analyzed. An action of the user is classified as an attention deficiency event using the analyzed attention level of the user.

25 Claims, 3 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

8,412,664	B2	4/2013	Shankle	
2003/0130595	A1	7/2003	Mault	
2009/0306484	A1*	12/2009	Kurtz	A61B 5/0059 600/300
2010/0185113	A1	7/2010	Peot et al.	
2010/0240458	A1	9/2010	Gaiba et al.	
2011/0060715	A1*	3/2011	Shankle	A61B 5/16 706/52

OTHER PUBLICATIONS

Kleeman, John, "Recent cognitive psychology research shows strongly that quizzes help retain learning. What does this mean for CAA?", International Computer Assisted Assessment (CAA) Conference, (2011), pp. 1-12.

Frequently asked questions, http://www.media.mit.edu/galvactivator/faq.html, (downloaded on Mar. 21, 2014), pp. 1-4.

Emotive EPOC—EPOC Specifications, Brain Computer Interface Technology, Emotiv (2012), 4 pages.

Denot-Ledunois, et al., "The effect of attentional load on the breathing pattern in children", International Journal of Psychophysiology 29 (1998) 13-21.

SWOV Fact sheet "Attention problems behind the wheel", SWOV Institute for Road Safety Research, (Feb. 2012), pp. 1-6.

Ravaja, Niklas, "Presence-Related Influences of a Small Talking Facial Image on Psychophysiological Measures of Emotion and Attention", Proceedings of the 5th Annual International Workshop Presence, (Oct. 9, 2002), 8 pages.

Bolls, et al., "The Effects of Message Valence and Listener Arousal on Attention, Memory, and Facial Muscular Responses to Radio Advertisements", Communication Research, vol. 28 No. 5, (Oct. 2001), pp. 627-651.

"Are You Really Paying Attention? Doppler Sonography Helps Psychologists Measure Attention Levels", http://old.sciencedaily.com/videos/2006/1212-are_you_really_paying_attention.htm, ScienceDaily, (Dec. 1, 2006), 3 pages.

MindWave headset, NeuroSky, http://store.neurosky.com/products/mindwave-1, (downloaded on Mar. 8, 2012), 3 pages.

Tarzia, et al., "Sonar-Based Measurement of User Attention", (USENIX, Jun. 2009), 2 pages.

* cited by examiner

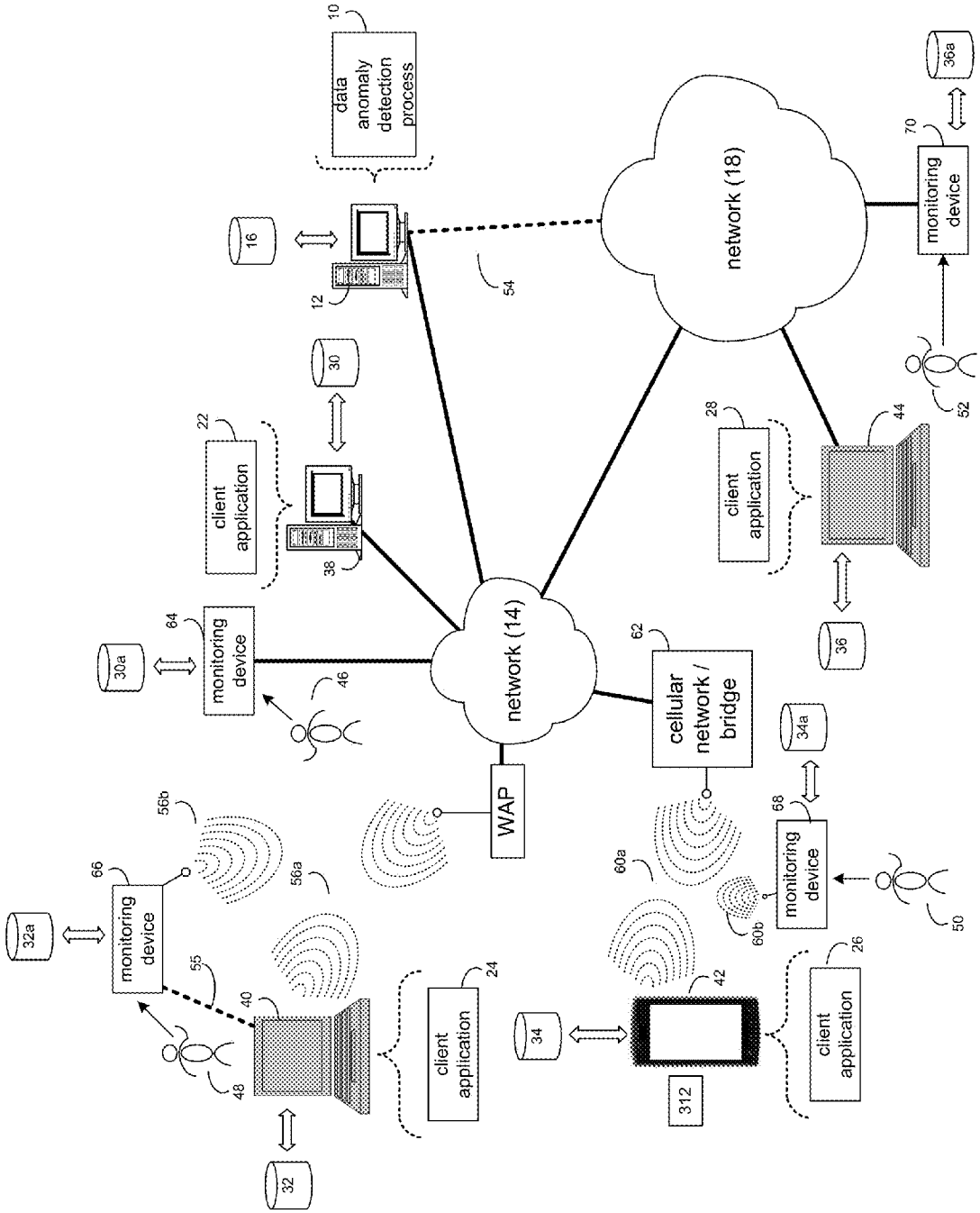

data anomaly detection process
10
network (18)
network (14)
WAP
cellular network / bridge
monitoring device
client application
16
12
54
30
38
22
64
30a
46
62
28
44
36
36a
70
52
34a
68
60a
60b
50
56b
56a
66
32a
55
40
48
24
32
42
312
34
26

FIG. 1

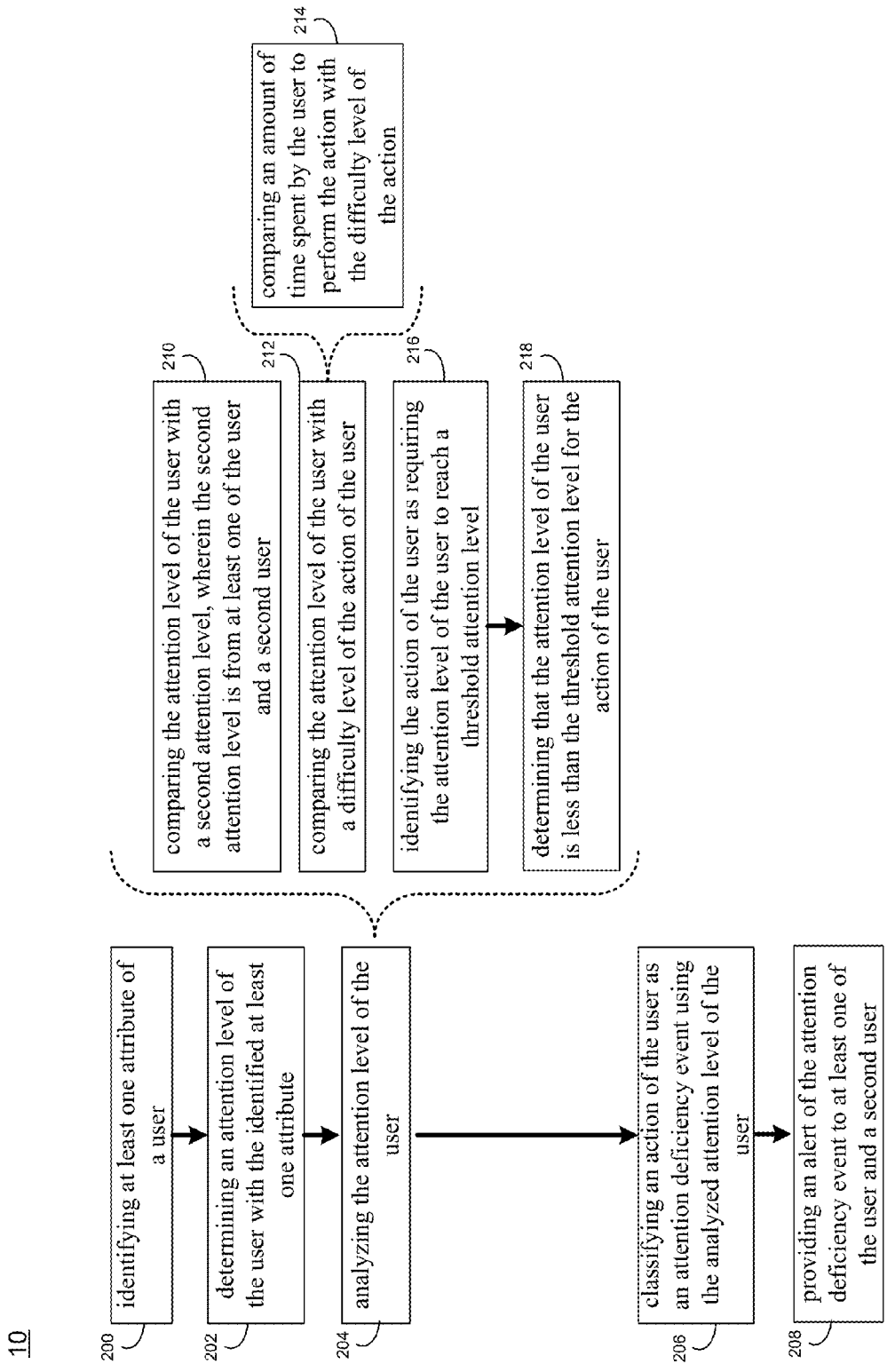
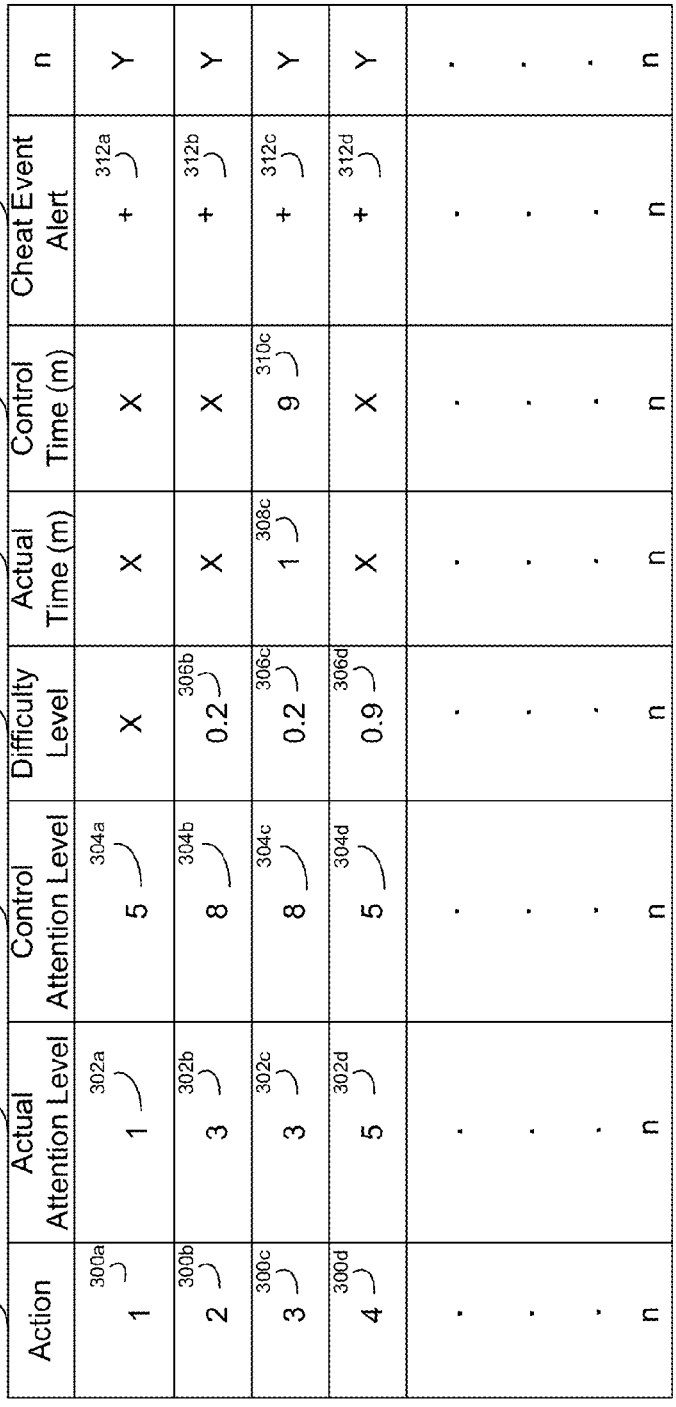

10
200
identifying at least one attribute of a user
202
determining an attention level of the user with the identified at least one attribute
204
analyzing the attention level of the user
210
comparing the attention level of the user with a second attention level, wherein the second attention level is from at least one of the user and a second user
212
comparing the attention level of the user with a difficulty level of the action of the user
214
comparing an amount of time spent by the user to perform the action with the difficulty level of the action
216
identifying the action of the user as requiring the attention level of the user to reach a threshold attention level
218
determining that the attention level of the user is less than the threshold attention level for the action of the user
206
classifying an action of the user as an attention deficiency event using the analyzed attention level of the user
208
providing an alert of the attention deficiency event to at least one of the user and a second user

FIG. 2



300 Action	302 Actual Attention Level	304 Control Attention Level	306 Difficulty Level	308 Actual Time (m)	310 Control Time (m)	312 Cheat Event Alert	n
300a 1	302a 1	304a 5	X	X	X	312a +	Y
300b 2	302b 3	304b 8	306b 0.2	X	X	312b +	Y
300c 3	302c 3	304c 8	306c 0.2	308c 1	310c 9	312c +	Y
300d 4	302d 5	304d 5	306d 0.9	X	X	312d +	Y
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
n	n	n	n	n	n	n	n

FIG. 3

SYSTEM AND METHOD FOR DATA ANOMALY DETECTION PROCESS IN ASSESSMENTS

RELATED CASES

This application claims the benefit of U.S. Provisional Application No. 61/873,443, filed on 4 Sep. 2013, and is a continuation in part of U.S. patent application Ser. No. 13/667,425 filed on 2 Nov. 2012, entitled System and Method for Data Anomaly Detection Process in Assessments, which claims the benefit of U.S. Provisional Application No. 61/555,748, filed on 4 Nov. 2011, the contents of which are hereby incorporated by reference.

TECHNICAL FIELD

This disclosure relates to assessment systems and methods and, more particularly, to assessment cheating detection systems and methods and to recording data related to the attentions levels of people paying attention to learning materials.

BACKGROUND

Assessments (e.g., exams) are used in many parts of society to measure knowledge, skills, abilities and behaviors, e.g., in order to certify people for job roles and qualifications or grant licenses to work or perform tasks. For instance, educational institutions may use exams to validate work, knowledge, and skills to give educational qualifications. As another example, during the recruitment or promotion processes, an organization may test how a candidate behaves under certain circumstances to see if the candidate will fit in with the culture. As yet another example, companies including Information Technology (IT) and other high-tech companies may issue certifications to people who can use or maintain products, or who are skilled with products. Organizations may use internal exams to confirm that people are competent to do jobs where failure has a high risk (e.g., financial services and trading, operators of power stations and transport operators, etc.). Government agencies may provide licenses-to-work based on exam results for many professional trades such as doctors, nurses, crane operators, etc., and for licenses to drive.

Some of these exams may be delivered by paper and/or remotely by computer, with a candidate using, e.g., a workstation or other device to answer questions. Part of the process of conducting an exam may be to minimize cheating. Common forms of cheating may include, for example, identity fraud (e.g., where someone other than the candidate claims to be the candidate), use of cheating materials (e.g., having access to books, the internet, or other resources in a closed-book exam), prompting another person giving the right answer (e.g., someone sitting by the candidate or via telephone), and copying answers (e.g., looking at how others taking the exams at the same time are answering questions and using the same answers).

There are many variants of cheating and with exams where little, inadequate, or no supervision is provided to the candidate, cheating may be a problem where society may not fully trust the integrity of the certifications, qualifications and licenses that the exams provide.

Lower stakes assessments may also be used to check understanding after e-learning or after other on-screen learning for instance during regulatory compliance competency checking, where employees are required to undergo training to teach regulations, processes and procedures and need to pay attention both during the learning and during the assessment.

SUMMARY OF DISCLOSURE

In one implementation, a method, performed by one or more computing devices, comprises identifying at least one attribute of a user. An attention level of the user is determined with the identified at least one attribute. The attention level of the user is analyzed. An action of the user is classified as an attention deficiency event using the analyzed attention level of the user.

One or more of the following features may be included. Analyzing the attention level of the user may include comparing the attention level of the user with a second attention level, wherein the second attention level may be from at least one of the user and a second user. Analyzing the attention level of the user may include comparing the attention level of the user with a difficulty level of the action of the user. Analyzing the attention level of the user may further include comparing an amount of time spent by the user to perform the action with the difficulty level of the action.

Analyzing the attention level of the user may include identifying the action of the user as requiring the attention level of the user to reach a threshold attention level, and determining that the attention level of the user is less than the threshold attention level for the action of the user. The action of the user may include answering one or more questions. An alert of the attention deficiency event may be provided to at least one of the user and a second user. The at least one attribute may include blood flow velocity. The at least one attribute may include bodily movement detection. The at least one attribute may include eye blink detection. The at least one attribute may include gaze detection. The at least one attribute may include heartbeat rate detection. The at least one attribute may include breathing detection. The at least one attribute may include brain electrical activity detection. The at least one attribute may include body posture detection. The at least one attribute may include sweat detection. The attention level of the user may be determined with a combination of at least two attributes of the user. The attention deficiency event may include a lack of learning by the user during a learning process. The attention deficiency event may include cheating by the user during an assessment.

In another implementation, a computer program product resides on a computer readable medium that has a plurality of instructions stored on it. When executed by a processor, the instructions cause the processor to perform operations comprising identifying at least one attribute of a user. An attention level of the user is determined with the identified at least one attribute. The attention level of the user is analyzed. An action of the user is classified as an attention deficiency event using the analyzed attention level of the user.

One or more of the following features may be included. Analyzing the attention level of the user may include comparing the attention level of the user with a second attention level, wherein the second attention level may be from at least one of the user and a second user. Analyzing the attention level of the user may include comparing the attention level of the user with a difficulty level of the action of the user. Analyzing the attention level of the user may

further include comparing an amount of time spent by the user to perform the action with the difficulty level of the action.

Analyzing the attention level of the user may include identifying the action of the user as requiring the attention level of the user to reach a threshold attention level, and determining that the attention level of the user is less than the threshold attention level for the action of the user. The action of the user may include answering one or more questions. An alert of the attention deficiency event may be provided to at least one of the user and a second user. The at least one attribute may include gaze detection. The at least one attribute may include bodily movement detection. The at least one attribute may include eye blink detection. The at least one attribute may include gaze detection. The at least one attribute may include heartbeat rate detection. The at least one attribute may include breathing detection. The at least one attribute may include brain electrical activity detection. The at least one attribute may include body posture detection. The at least one attribute may include sweat detection. The attention level of the user may be determined with a combination of at least two attributes of the user. The attention deficiency event may include a lack of learning by the user during a learning process. The attention deficiency event may include cheating by the user during an assessment.

In another implementation, a computing system includes a processor and memory configured to perform operations comprising identifying at least one attribute of a user. An attention level of the user is determined with the identified at least one attribute. The attention level of the user is analyzed. An action of the user is classified as an attention deficiency event using the analyzed attention level of the user.

One or more of the following features may be included. Analyzing the attention level of the user may include comparing the attention level of the user with a second attention level, wherein the second attention level may be from at least one of the user and a second user. Analyzing the attention level of the user may include comparing the attention level of the user with a difficulty level of the action of the user. Analyzing the attention level of the user may further include comparing an amount of time spent by the user to perform the action with the difficulty level of the action.

Analyzing the attention level of the user may include identifying the action of the user as requiring the attention level of the user to reach a threshold attention level, and determining that the attention level of the user is less than the threshold attention level for the action of the user. The action of the user may include answering one or more questions. An alert of the attention deficiency event may be provided to at least one of the user and a second user. The at least one attribute may include gaze detection. The at least one attribute may include bodily movement detection. The at least one attribute may include eye blink detection. The at least one attribute may include gaze detection. The at least one attribute may include heartbeat rate detection. The at least one attribute may include breathing detection. The at least one attribute may include brain electrical activity detection. The at least one attribute may include body posture detection. The at least one attribute may include sweat detection. The attention level of the user may be determined with a combination of at least two attributes of the user. The attention deficiency event may include a lack of learning by the user during a learning process. The attention deficiency event may include cheating by the user during an assessment.

The details of one or more implementations are set forth in the accompanying drawings and the description below. Other features and advantages will become apparent from the description, the drawings, and the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an illustrative diagrammatic view of a data anomaly detection process coupled to a distributed computing network;

FIG. **2** is an illustrative flowchart of the data anomaly detection process of FIG. **1**; and

FIG. **3** is an illustrative table containing information that may be used by the data anomaly detection process of FIG. **1**.

Like reference symbols in the various drawings indicate like elements.

DETAILED DESCRIPTION OF THE EMBODIMENTS

System Overview

As will be appreciated by one skilled in the art, the present disclosure may be embodied as a method, system, or computer program product. Accordingly, the present disclosure may take the form of an entirely hardware implementation, an entirely software implementation (including firmware, resident software, micro-code, etc.) or an implementation combining software and hardware aspects that may all generally be referred to herein as a "circuit," "module" or "system." Furthermore, the present disclosure may take the form of a computer program product on a computer-usable storage medium having computer-usable program code embodied in the medium.

Any suitable computer usable or computer readable medium may be utilized. The computer readable medium may be a computer readable signal medium or a computer readable storage medium. The computer-usable, or computer-readable, storage medium (including a storage device associated with a computing device or client electronic device) may be, for example, but is not limited to, an electronic, magnetic, optical, electromagnetic, infrared, or semiconductor system, apparatus, device, or any suitable combination of the foregoing. More specific examples (a non-exhaustive list) of the computer-readable medium may include the following: an electrical connection having one or more wires, a portable computer diskette, a hard disk, a random access memory (RAM), a read-only memory (ROM), an erasable programmable read-only memory (EPROM or Flash memory), an optical fiber, a portable compact disc read-only memory (CD-ROM), an optical storage device, a media such as those supporting the internet or an intranet, or a magnetic storage device. Note that the computer-usable or computer-readable medium could even be a suitable medium upon which the program is stored, scanned, compiled, interpreted, or otherwise processed in a suitable manner, if necessary, and then stored in a computer memory. In the context of this document, a computer-usable or computer-readable, storage medium may be any tangible medium that can contain or store a program for use by or in connection with the instruction execution system, apparatus, or device.

A computer readable signal medium may include a propagated data signal with computer readable program code embodied therein, for example, in baseband or as part of a carrier wave. Such a propagated signal may take any of a variety of forms, including, but not limited to, electromagnetic, optical, or any suitable combination thereof. The computer readable program code may be transmitted using any appropriate medium, including but not limited to the internet, wireline, optical fiber cable, RF, etc. A computer readable signal medium may be any computer readable medium that is not a computer readable storage medium and that can communicate, propagate, or transport a program for use by or in connection with an instruction execution system, apparatus, or device.

Computer program code for carrying out operations of the present disclosure may be written in an object oriented programming language such as Java®, Smalltalk, C++ or the like. Java and all Java-based trademarks and logos are trademarks or registered trademarks of Oracle and/or its affiliates. However, the computer program code for carrying out operations of the present disclosure may also be written in conventional procedural programming languages, such as the "C" programming language, PASCAL, or similar programming languages, as well as in scripting languages such as Javascript or PERL. The program code may execute entirely on the user's computer, partly on the user's computer, as a stand-alone software package, partly on the user's computer and partly on a remote computer or entirely on the remote computer or server. In the latter scenario, the remote computer may be connected to the user's computer through a local area network (LAN) or a wide area network (WAN), or the connection may be made to an external computer (for example, through the internet using an Internet Service Provider).

The flowchart and block diagrams in the figures illustrate the architecture, functionality, and operation of possible implementations of apparatus (systems), methods and computer program products according to various implementations of the present disclosure. It will be understood that each block in the flowchart and/or block diagrams, and combinations of blocks in the flowchart and/or block diagrams, may represent a module, segment, or portion of code, which comprises one or more executable computer program instructions for implementing the specified logical function (s)/act(s). These computer program instructions may be provided to a processor of a general purpose computer, special purpose computer, or other programmable data processing apparatus to produce a machine, such that the computer program instructions, which may execute via the processor of the computer or other programmable data processing apparatus, create the ability to implement one or more of the functions/acts specified in the flowchart and/or block diagram block or blocks or combinations thereof. It should be noted that, in some alternative implementations, the functions noted in the block(s) may occur out of the order noted in the figures. For example, two blocks shown in succession may, in fact, be executed substantially concurrently, or the blocks may sometimes be executed in the reverse order, depending upon the functionality involved.

These computer program instructions may also be stored in a computer-readable memory that can direct a computer or other programmable data processing apparatus to function in a particular manner, such that the instructions stored in the computer-readable memory produce an article of manufacture including instruction means which implement the function/act specified in the flowchart and/or block diagram block or blocks or combinations thereof.

The computer program instructions may also be loaded onto a computer or other programmable data processing apparatus to cause a series of operational steps to be performed (not necessarily in a particular order) on the computer or other programmable apparatus to produce a computer implemented process such that the instructions which execute on the computer or other programmable apparatus provide steps for implementing the functions/acts (not necessarily in a particular order) specified in the flowchart and/or block diagram block or blocks or combinations thereof.

Referring to FIG. **1**, there is shown data anomaly detection process **10** that may reside on and may be executed by computer **12**, which may be connected to network **14** (e.g., the internet or a local area network). Examples of computer **12** may include but are not limited to a single server computer, a series of server computers, a single personal computer, a series of personal computers, a mini computer, a tablet computer, a mainframe computer, or a computing cloud. The various components of computer **12** may execute one or more operating systems, examples of which may include but are not limited to: Microsoft Windows Server™; Novell Netware™; Redhat Linux™, Unix, Mobile phone or tablet OS, or a custom operating system, for example.

As will be discussed below in greater detail, data anomaly detection process **10** may detect cheating, e.g., in an assessment. For example, at least one attribute of a user may be identified, e.g., via monitoring device **64**, **66**, **68**, **70**. An attention level of the user may be determined with the identified at least one attribute. The attention level of the user may be analyzed. An action of the user may be classified as an attention deficiency event using the analyzed attention level of the user.

The instruction sets and subroutines of data anomaly detection process **10**, which may be stored on storage device **16** coupled to computer **12**, may be executed by one or more processors (not shown) and one or more memory architectures (not shown) included within computer **12**. Storage device **16** may include but is not limited to: a hard disk drive; a flash drive, a tape drive; an optical drive; a RAID array; a random access memory (RAM); and a read-only memory (ROM).

Network **14** may be connected to one or more secondary networks (e.g., network **18**), examples of which may include but are not limited to: a local area network; a wide area network; or an intranet, for example.

Computer **12** may include a data store, such as a database (e.g., relational database) (not shown) and may be located within any suitable memory location, such as storage device **16** coupled to computer **12**. In some embodiments, computer **12** may utilize a database management system such as, but not limited to, "My Structured Query Language" (MySQL) in order to provide multi-user access to one or more databases, such as the above noted relational database. The data store may also be a custom database, such as, for example, a flat file database or an XML database. Any other form(s) of a data storage structure may also be used. Data anomaly detection process **10** may be a component of the database, a stand alone application that interfaces with the above noted data store and/or an applet/application that is accessed via client applications **22**, **24**, **26**, **28**. The above noted data store may be, in whole or in part, distributed in a cloud computing topology. In this way, computer **12** and storage device **16** may refer to multiple devices, which may also be distributed throughout the network.

Data anomaly detection process **10** may be accessed via client applications **22**, **24**, **26**, **28**. Examples of client appli-

cations **22**, **24**, **26**, **28** may include but are not limited to an assessment application, monitoring device application, standard and/or mobile web browser, email client application, a customized web browser, or a custom application. The instruction sets and subroutines of client applications **22**, **24**, **26**, **28**, which may be stored on storage devices **30** and/or **30***a*, **32** and/or **32***a*, **34** and/or **34***a*, **36** and/or **36***a* coupled to client electronic devices **38**, **40**, **42**, **44** and/or monitoring devices **64**, **66**, **68**, **70**, may be executed by one or more processors (not shown) and one or more memory architectures (not shown) incorporated into client electronic devices **38**, **40**, **42**, **44** and/or monitoring devices **64**, **66**, **68**, **70**.

Monitoring devices **64**, **66**, **68**, **70** may include known brainwave monitoring devices and/or known gaze monitoring devices (e.g., that may include embedded Gaze Tracking or other attention tracking software inside test delivery software) or other attention monitoring devices, which may be enabled (e.g., via data anomaly detection process **10** and/or client applications **22**, **24**, **26**, **28**) to track and record data related to a user's gaze or other attention measures, stop a test if a threshold number of distractions are evident (e.g., detected), record data in a transactional test taking database, convert to a data warehouse and/or do the analysis in the transactional database to find, e.g., data anomalies that may indicate cheating and/or correlations between a user's gaze and question difficulty to help improve a detection model.

Storage devices **30**, **30***a*, **32**, **32***a*, **34**, **34***a*, **36**, **36***a* may include but are not limited to: hard disk drives; flash drives, tape drives; optical drives; RAID arrays; random access memories (RAM); and read-only memories (ROM). Examples of client electronic devices **38**, **40**, **42**, **44** may include, but are not limited to, personal computer **38**, laptop computer **40**, smart phone **42**, notebook computer **44**, a tablet (not shown), a server (not shown), a data-enabled, cellular telephone (not shown), a television (not shown) with one or more processors embedded therein or coupled thereto, and a dedicated network device (not shown). Additionally/alternatively, client electronic devices **38**, **40**, **42**, **44** may include a monitoring device (e.g., monitoring device **64**, **66**, **68**, **70**).

One or more of client applications **22**, **24**, **26**, **28** may be configured to effectuate some or all of the functionality of data anomaly detection process **10** and/or may include at least some of data anomaly detection process **10**. Accordingly, data anomaly detection process **10** may be a purely server-side application, a purely client-side application, or a hybrid server-side/client-side application that is cooperatively executed by one or more of client applications **22**, **24**, **26**, **28** and data anomaly detection process **10**.

Users **46**, **48**, **50**, **52** and/or monitoring devices **64**, **66**, **68**, **70** may access computer **12** and data anomaly detection process **10** directly through network **14** or through secondary network **18**. Further, computer **12** may be connected to network **14** through secondary network **18**, as illustrated with phantom link line **54**. Data anomaly detection process **10** may include one or more user interfaces, such as browsers and textual or graphical user interfaces, through which users **46**, **48**, **50**, **52** and/or monitoring devices **64**, **66**, **68**, **70** may access data anomaly detection process **10**.

The various client electronic devices and/or monitoring devices **64**, **66**, **68**, **70** may be directly or indirectly coupled to network **14** (or network **18**). For example, personal computer **38** and monitoring device **64** are shown directly coupled to network **14** via a hardwired network connection. Further, notebook computer **44** and monitoring device **70** are shown directly coupled to network **18** via a hardwired network connection. Laptop computer **40** and monitoring device **66** are shown wirelessly coupled to network **14** via wireless communication channels **56***a* and **56***b* respectively established between laptop computer **40** and wireless access point (i.e., WAP) **58** and between monitoring device **66** and WAP **58**, which is shown directly coupled to network **14**. WAP **58** may be, for example, an IEEE 802.11a, 802.11b, 802.11g, Wi-Fi, and/or Bluetooth™ device that is capable of establishing wireless communication channel **56***a* between laptop computer **40** and WAP **58** and wireless communication channel **56***b* between monitoring device **66** and WAP **58**. Additionally/alternatively, a monitoring device (e.g., monitoring device **66**) may be directly (and/or wirelessly) coupled to a client electronic device (e.g., client electronic device **40**) as illustrated with phantom link line **55**. Thus, information may be communicated from a monitoring device (e.g., monitoring device **66**) to a client electronic device (e.g., client electronic device **40**), where the information may be communicated, e.g., to computer **12** via, e.g., a network (e.g., network **14**). Smart phone **42** and monitoring device **68** are shown wirelessly coupled to network **14** via wireless communication channels **60***a* and **60***b* respectively established between smart phone **42** and cellular network/bridge **62** and monitoring device **68** and cellular network/bridge **62**, which is shown directly coupled to network **14**.

As is known in the art, all of the IEEE 802.11x specifications may use Ethernet protocol and carrier sense multiple access with collision avoidance (i.e., CSMA/CA) for path sharing. The various 802.11x specifications may use phase-shift keying (i.e., PSK) modulation or complementary code keying (i.e., CCK) modulation, for example. As is known in the art, Bluetooth™ is a telecommunications industry specification that allows, e.g., mobile phones, computers, smart phones, and other devices (e.g., monitoring devices **64**, **66**, **68**, **70**) to be interconnected using a short-range wireless connection.

Client electronic devices **38**, **40**, **42**, **44** may each execute an operating system, examples of which may include but are not limited to Android™, Apple iOS™, Microsoft Windows™, Redhat Linux™, or a custom operating system.

The Data Anomaly Detection Process:

As discussed above and referring also to FIGS. **2**-**3**, data anomaly detection process **10** may identify **200** at least one attribute of a user. An attention level of the user may be determined **202** by data anomaly detection process **10** with the identified **200** at least one attribute. The attention level of the user may be analyzed **204** by data anomaly detection process **10**. An action of the user may be classified **206** by data anomaly detection process **10** as an attention deficiency event using the analyzed **204** attention level of the user.

For example, data anomaly detection process **10** may detect cheating, e.g., in an assessment. For example, attributes of a user (e.g., user **48**), such as but not limited to brainwaves and/or a gaze of the user, may be monitored and/or measured (e.g., via data anomaly detection process **10**) and/or subsequently identified **200** by data anomaly detection process **10**. This may be achieved, for example, using, e.g., monitoring device **66**, which may include known brainwave and/or gaze monitoring devices (e.g., Embed Gaze Tracking software inside test delivery software).

In some implementations, it may be possible to reduce live motoring requirements for internal exams by a significant amount, perhaps from, e.g., 100% to 10%. In some implementations, the presence of attention detecting process **10** may also deter candidates from cheating. Warning candidates that their gaze and other attention measures are being tracked is likely to deter candidates from cheating. If an

attention data anomaly is identified, it is possible to stop the current assessment and require later live monitoring to ensure that potential cheaters are given a chance to prove their competence by doing the test while being monitored by a live person; among other possibilities. For instance, assuming for example purposes only that live monitoring costs $20/hour, average test length is 1 hour, and an organization delivers 50,000 exams per year, live monitoring may cost in the order of $1,000,000; however, gaze monitoring may reduce the number of participants that may need monitoring (e.g., 10% may still require live monitoring), which may cost, e.g., $100,000 and so savings may be in the order of $900,000/year, just as an example.

The brainwaves and/or the gaze and/or attention of user **48** may be monitored, measured, and identified **200** directly from monitoring device **66** and/or client electronic device **40**, e.g., via data anomaly detection process **10**. Additionally/alternatively, the brainwaves and/or the gaze and/or attention of user **48** may at any point be recorded on one or more storage devices (e.g., storage device **32** and/or **32***a*) and/or communicated using any appropriate means noted throughout (e.g., wireless communication channels **56***a* and **56***b*, phantom link line **55**, etc.) to be recorded on one or more storage devices (e.g., storage devices **16**, **30**, **30***a*, **32**, **32***a*, **34**, **34***a*, **36**, **36***a*) and subsequently identified **200** by data anomaly detection process **10**. Therefore, any particular description of where and when the brainwaves and/or the gaze and/or attention of user **48** are monitored, measured, identified **200** (and as discussed further below, determined **202**, analyzed **204**, and classified **206**, etc.) by data anomaly detection process **10** using any particular device(s) in any combination should be taken as an example only and not to limit the scope of the disclosure.

An attention/distraction level (e.g., attention level **302**) of user **48** may be determined **202** by data anomaly detection process **10** with the identified brainwaves and/or gaze and/or other attention measurement. For instance, according to one or more example embodiments, monitoring device **66** and/or client electronic device **40** may include the capability to monitor user characteristics of user **48**, such as the gaze of user **48**. For example, monitoring device **66** and/or client electronic device **40** may include the capability of gaze monitoring, which may be achieved using, e.g., a video camera and software to identify the facial and eye movements. Data anomaly detection process **10** may correlate the time looking at the screen, and/or pupil dilation, and/or eye movements, and/or, and/or looking at specific parts of the screen and/or looking away from the screen and/or more detailed eye vergence measurement with regard to the screen and/or facial and/or head movements related to position of the screen. For instance, looking (or other head/eye positioning) at a specific area of the screen may be associated by data anomaly detection process **10** with various degrees of active thinking, cognitive load, concentration, state of mind, etc. (i.e., attention level, distraction level, etc.). And looking away (or other related head, neck, face, eye positioning or movement) from the screen might be an indication of possible cheating as it could mean looking at another device or at another person or at information that is not supposed to be seen, e.g., a book or "cheat sheet".

As another example, according to one or more example embodiments, monitoring device **66** and/or client electronic device **40** may include the capability to monitor user characteristics of user **48**, such as brainwaves and/or heart rate. For instance, the capability of brainwave monitoring may be achieved using, e.g., Electroencephalography (EEG) technology which may measure electronic activity (e.g., varying voltages) within the brain from, e.g., the scalp of user **48** and the other measures for attention detection mentioned above may be used. EEG may show oscillations at various frequency ranges. Data anomaly detection process **10** may correlate the frequency ranges and/or special distributions with brain activity and also compare gaze detection with head/facial movements and other mechanisms. These may be associated by data anomaly detection process **10** with various degrees of active thinking, cognitive load, concentration, state of mind, etc. (i.e., attention level). However, those skilled in the art will recognize that other techniques may be used to identify attention level **302** of user **48** using, for example, brainwave monitoring and analysis **204**. For example, the raw measurements of attention may be converted, e.g., by data anomaly detection process **10**, into another form (e.g., digital representation) for subsequent analysis **204**. As another example, a signature of the brainwaves and/or the gaze summarizing attention level **302** and/or **304** of user **48** may be used, e.g., by data anomaly detection process **10**, for subsequent analysis **204**. As such, the specific description of analyzing **204** the brainwaves and/or the gaze may include any combination of the raw and manipulated data.

As noted above, attention level **302** and/or **304** of user **48** may be analyzed **204** by data anomaly detection process **10** using the brainwaves and/or the gaze and of user **48**. For example, brainwave and/or gaze analysis **204** may allow data anomaly detection process **10** to determine whether user **48** is/was cheating and/or whether there is a high likelihood that user **48** is/was cheating. For example, answering questions may require user **48** to make deductions, calculations, etc., to decide the correct answer properly and fairly, which may require a certain range of attention levels (as indicated, e.g., via identified **200** brainwaves and/or the gaze), and if user **48** is/was cheating, the range of attention levels may be noticeably (e.g., measurably) different. For instance, user **48** may be asked identity questions about user **48** and likely may require a low attention level to answer, however, when cheating with identity fraud (e.g., where user **46** takes an exam in place of user **48**), user **46** may require a higher attention level to answer the same questions about user **48**. As another example, when cheating by user **48** knowing the questions, choices, and correct answers in advance and answering based on memory rather than knowledge, the attention level required by user **48** to answer the question may be minimal. User **48** may also either answer quickly, or if user **48** finishing quickly is a cheater detection method, user **48** may answer quickly and then "daydream" or otherwise think without concentrated attention (i.e., a lower attention level). As another example, cheating by user **48** being prompted by another with the correct answer or copying answers from a fellow test taker, or using a cheat sheet during a closed-book exam, may require a noticeably decreased attention level and/or looking in a specific other direction by user **48**. Other cheating techniques may also be attempted by user **48** with varying attention levels or directions of gaze being required in the process. In some implementations, some test takers may be visually impaired and so the gaze detection process may be unreliable for such test takers, but these people may be identified and an accommodation potentially allowed not to use the gaze identification portion of anomaly detection for their tests. In some implementations, some test takers may have a habit of paying attention while looking in an unexpected direction (e.g., "staring into space"), but such habits may be detected by analyzing the data from multiple tests/exams.

Therefore, consider the following non-limiting examples of data anomaly detection process **10** analyzing **204** attention level **302** of user **48**, for example, where user **48** is performing an action (e.g., action **300**) of answering questions on an exam:

Analyzing **204** attention level **302** of user **48** by data anomaly detection process **10** may include comparing **210** attention level **302** of user **48** with a second attention level (e.g., control attention level **304**), wherein control attention level **304** may be from at least one of user **48** and a second user (e.g., user **48** and/or user **46**). For instance, assume for example purposes only that user **48** and the second user are the same user. Further assume for example purposes only that a first exam (e.g., a calibration exercise for user **48** to determine a control norm) was previously taken by user **48** where the attention levels for answering different question types (e.g., easy, medium, hard) are determined **202** (e.g., as control attention level **304**) and where the control attention level **304***a* of user **48** for the difficult question type is determined **202**. Further assume for example purposes only that a second exam (e.g., the real exam) is later taken by user **48** where the attention levels for answering the same question types of the first exam are determined **202**. Further assume for example purposes only that the control attention level (e.g., **304***a*) of user **48** answering the hard question (e.g., action **300***a*) on the first exam is analyzed **204** by data anomaly detection process **10** to be significantly higher than the actual attention level (e.g., **302***a*) of user **48** answering the hard question on the second exam, action **300***a* of user **48**. The extent of the analyzed **204** difference in attention level may be indicative of a cheating event (e.g., anomaly) where unauthorized help was used by user **48** to significantly lessen the attention level needed to answer the same difficulty question type. As a result, data anomaly detection process **10** may classify **206** action **300***a* as a possible cheating event using, e.g., attention level(s) **302***a* and/or **304***a* of user **48**. Those skilled in the art will appreciate that any number of attention levels (and/or their associated averages) for any number of users may be used as a benchmark (e.g., threshold) for the comparison.

As used herein, the terms attention and distraction may be used interchangeably where appropriate. In some implementations, analyzing **204** distraction level **302** of user **48** by data anomaly detection process **10** may include comparing **210** distraction level **302** of user **48** with a second distraction level (e.g., control distraction level **304**), wherein control distraction level **304** may be from at least one of user **48** and a second user (e.g., user **48** and/or user **46**). For instance, assume for example purposes only that user **48** and the second user are the same user. Further assume for example purposes only that a first exam (e.g., a calibration exercise for user **48** to determine a control norm) was previously taken by user **48** where the distraction levels for answering different question types (e.g., easy, medium, hard) are determined **202** (e.g., as control distraction level **304**) and where the control distraction level **304***a* of user **48** for the difficult question type is determined **202**. Further assume for example purposes only that a second exam (e.g., the real exam) is later taken by user **48** where the distraction levels for answering the same question types of the first exam are determined **202**. Further assume for example purposes only that the control distraction level (e.g., **304***a*) of user **48** answering the hard question (e.g., action **300***a*) on the first exam is analyzed **204** by data anomaly detection process **10** to be significantly lower than the actual distraction level (e.g., **302***a*) of user **48** answering the hard question on the second exam, action **300***a* of user **48**. The extent of the analyzed **204** difference in distraction level may be indicative of a cheating event (e.g., anomaly) where unauthorized help was used by user **48** to increase the distraction level to answer the same difficulty question type. As a result, data anomaly detection process **10** may classify **206** action **300***a* as a possible cheating event using, e.g., distraction level(s) **302***a* and/or **304***a* of user **48**. Those skilled in the art will appreciate that any number of distraction levels (and/or their associated averages) for any number of users may be used as a benchmark (e.g., threshold) for the comparison.

Additionally/alternatively, if data anomaly detection process **10** classifies **206**, e.g., action **300***a*, as an attention deficiency event, (e.g., which may include a possible cheating event and/or attention deficiency event), data anomaly detection process **10** may provide **208** alert **312** (e.g., cheat event alert **312***a*) of the cheating event to at least one of user **48** and a second user (e.g., user **50** via client electronic device **42**). User **50** may include, for example, a monitor (also known as supervisor, proctor or invigilator) or other authority responsible for investigating and ensuring the validity of action **300**, and need not be another test taker as illustratively shown.

Data anomaly detection process **10** may classify **206** any action (e.g., **300***a*) as a possible cheating event, for example, on-the-fly and/or in post-assessment analysis. If classified **206** on-the-fly, data anomaly detection process **10** (and/or the supervisor) may stop the exam, where user **48** may be instructed to take the exam at another time (and sometimes in another place or in a more supervised environment). Additionally/alternatively, data anomaly detection process **10** may provide **208** an alert (e.g., alert **312***a*) to instruct user **50** to check on user **48** or to increase the level of monitoring in person and/or by video (e.g., immediately and/or in the future) or in some other way increase vigilance or gather further data. Additionally/alternatively, if classified **206** by post-assessment analysis, data anomaly detection process **10** may provide **208** an alert (e.g., alert **312***a*) to instruct user **50** to monitor user **48** closer in the future. Additionally/alternatively, if no brainwaves and/or the gaze are detected, similar action may be taken, since, e.g., otherwise one may avoid the process by, e.g., disabling the monitoring device.

Additionally/alternatively, those skilled in the art will recognize that the second user (e.g., user **46**) may be different than user **48**. As such, control attention level **304***a* may be, for example, a comparison between attention level **302***a* used by user **46** to perform action **300***a* and attention level **304***a* used by user **48** to perform action **300***a*. If the attention level used to perform action **300***a* differs significantly between users **48** and **46**, this may be indicative of a cheating event where unauthorized help was used by one of users **48** and **50** to significantly lessen the attention level needed to answer the same difficulty question type. Additionally/alternatively, those skilled in the art will recognize that the control attention level **304** (e.g., **304***a*) may be an average of multiple users performing action **300** (e.g., action **300***a*) within an acceptable attention level limit. Therefore, any particular description of control attention level **304** should be taken as an example only and not to limit the scope of the disclosure.

Additionally/alternatively, data anomaly detection process **10** analyzing **204** attention level **302** of user **48** may include comparing **212** attention level **302** of user **48** with a difficulty level (e.g., difficulty level **306**) of action **300** taken by user **48**. For example, question difficulty may be measured as, e.g., a number or p value (e.g., as a number from 0 to 1), being the chance of average candidates correctly answering action **300** (so a p value of 0.7 means that 70%

of candidates correctly answer). For example, an "easy" question may be a 0.9 difficulty level and a "hard" question may be a 0.2 difficulty level. Other methods of measuring question difficulty (e.g., item response theory) may also be used. Those skilled in the art will appreciate that other techniques of calculating question difficulty may also be used without departing from the scope of the disclosure, and that question difficulty may vary with the test-taker's competence so that a question that is difficult for a beginner may be easy for an expert (e.g., data anomaly detection process **10** may take into account what is the expected cognitive load vs. the actual cognitive load). Generally, harder questions may take longer to answer than easier questions, and harder questions may also require a higher attention level and/or a reduced distraction level than easier questions. As such, an analysis **204** which compares **212** a user's attention level while performing action **300** (e.g., answering a question) with the difficulty level (e.g., difficulty level **306**) may be used by data anomaly detection process **10** to distinguish and to classify **206** a user (e.g., user **48**) as cheating and/or having a high probability of cheating. For example, assume for example purposes only that the difficulty level (e.g., difficulty level **306***b*) of action **300***b* is high (e.g., 0.2). As such, control attention level **304***b* of user **48** may on average be high (e.g., around 8 using a scale of 1-10). Further assume for example purposes only that user **48** performs action **300***b* and data anomaly detection process **10** determines **202** the attention level (attention level **302***b*) of user **48** for performing action **300***b* is (e.g., 3). The extent of the analyzed **204** difference in attention level **302***b* verses difficulty level **306***b* (and/or control attention level **304***b*) may be indicative of a cheating event where unauthorized help was used by user **48** to significantly lessen the attention level needed to answer a difficult question (i.e., action **300***b*). As a result, data anomaly detection process **10** may classify **206** action **300***b* as a possible cheating event using, e.g., attention level **302***b* of user **48**.

Additionally/alternatively, as noted above, if data anomaly detection process **10** classifies **206** action **300***b* as a possible cheating event, data anomaly detection process **10** may provide **208** alert **312** (e.g., cheat event alert **312***b*) of the cheating event to at least one of user **48** and a second user (e.g., user **50** via client electronic device **42**).

Additionally/alternatively, data anomaly detection process **10** analyzing **204** attention level **302** of user **48** may further include comparing **214** an amount of time (e.g., actual time **308** and/or control time **310**) spent by user **48** to perform action **300** with difficulty level **306** of action **300**. For example, data anomaly detection process **10** may more accurately analyze **204** attention level **302** of user **48** if, for example, time (e.g., actual time **308**) is also incorporated into the analysis **204**. For instance, assume for example purposes only that the difficulty level (e.g., difficulty level **306***c*) of action **300***c* is high (e.g., 0.2). As such, control attention level **304***c* of user **48** may on average be high (e.g., around 8). Further assume for example purposes only that user **48** performs action **300***c* and data anomaly detection process **10** determines **202** the attention level (attention level **302***c*) of user **48** for performing action **300***c* is (e.g., 3). Further assume for example purposes only that user **48** performs action **300***c* in an amount of time **308***c* (e.g., 1 minute) that is similar to an amount of time as would be performed with an easier action. The extent of the analyzed **204** difference in attention level **302***c* versus difficulty level **306***c* (and/or control attention level **304***c*) when also compared **214** with amount of time **308***c* used by user **48** when answering action **300***c* may be a stronger indication of a cheating event where unauthorized help was used by user **48** to answer a difficult question (i.e., action **300***c*). As a result, data anomaly detection process **10** may classify **206** action **300***c* as a possible cheating event using attention level **302***c* of user **48**.

Additionally/alternatively, as noted above, if data anomaly detection process **10** classifies **206** action **300***c* as a cheating event, data anomaly detection process **10** may provide **208** alert **312** (e.g., cheat event alert **312***c*) of the cheating event to at least one of user **48** and a second user (e.g., user **50** via client electronic device **42**).

Additionally/alternatively, further assume for example purposes only that user **48** performs action **300***c* in an amount of time **308***c* (e.g., 1 minute) where a control amount of time (e.g., control time **310***c*) around which user **48** should spend on average on action **300***c* is, e.g., 9 minutes. The extent of the analyzed **204** difference in attention level **302***c*, difficulty level **306***c* (and/or control attention level **304***c*), and amount of time **308***c* used by user **48** when answering action **300***c* compared **214** with control time **310***c* may be a stronger indication of a cheating event where unauthorized help was used by user **48** to answer a difficult question (i.e., action **300***c*). As a result, data anomaly detection process **10** may classify **206** action **300***c* as a possible cheating event using, e.g., attention level **302***c* of user **48**.

Additionally/alternatively, as noted above, if data anomaly detection process **10** classifies **206** action **300***c* as a cheating event, data anomaly detection process **10** may provide **208** alert **312** (e.g., cheat event alert **312***c*) of the cheating event to at least one of user **48** and a second user (e.g., user **50** via client electronic device **42**).

Additionally/alternatively, data anomaly detection process **10** analyzing **204** attention level **302** of user **48** may include identifying **216** action **300** of user **48** as requiring attention level **302** of user **48** to reach a threshold attention level (e.g., control attention level **304**), and determining **218** whether attention level **302** of user **48** is less than control attention level **304** for action **300** of user **48**. For example, one or more actions may require all users to spend some time and attention. For instance, an action that only requires a user to know a fact may be difficult, but may not necessarily require prolonged attention. Consider for example purposes only the following two actions: (1) "What is the value of it to two decimal places?" (2) "There are 4 circles, one with radius 1 cm, one with radius 4 cm, one with radius 6 cm and one with radius 10 cm. What is the combined area of all four circles to two decimal places?"

Even if a user (e.g., user **48**) were a strong mathematician, user **48** may still need to concentrate and pay attention to the second action (e.g., action **300***d*) to a certain threshold attention level (e.g., control attention level **304***d*), even if action **300***d* is not considered to be that of a high difficulty level **306***d* (e.g., 0.2). Thus, it may be useful for data anomaly detection process **10** to analyze **204** and identify **216** questions which may require a higher attention level and determine **218** whether attention level **302***d* of user **48** is less than control attention level **304***d* for action **300***d*. If data anomaly detection process **10** determines **218** that attention level **302***d* of user **48** is less than control attention level **304***d* for action **300***d*, data anomaly detection process **10** may classify **206** action **300***d* as a cheating event using, e.g., attention level **302***d* of user **48**.

Additionally/alternatively, as noted above, if data anomaly detection process **10** classifies **206** action **300***d* as a cheating event, data anomaly detection process **10** may provide **208** alert **312** (e.g., cheat event alert **312***d*) of the

cheating event to at least one of user **48** and a second user (e.g., user **50** via client electronic device **42**).

While action **300** taken by user **48** may include the answering of one or more questions, those skilled in the art will appreciate that other tasks may be associated with action **300**. For example, action **300** may include but is not limited to, performing a manual task, such as solving a puzzle, writing a document (e.g., to detect plagiarism), reading, researching, deciding which input device (e.g., keyboard) key to press, or performing any other cognitive task. As such, any particular description of action **300** being a question to answer should be taken as an example only and not to limit the scope of the disclosure.

While one or more embodiments of the disclosure is described in terms of data anomaly detection process **10** analyzing **204** brainwaves and/or the gaze and/or other attention detection measures, those skilled in the art will appreciate that other biological characteristics may also be used without departing from the scope of the disclosure. For example, monitoring device **66** may include heart rate monitoring capabilities used, e.g., by data anomaly detection process **10**, to determine **202** a heart rate of user **48**, where the heart rate may be analyzed **204** by data anomaly detection process **10**, e.g., similarly to the operation of a lie detector. As such any particular description of analyzing brainwaves and/or the gaze and/or the attention should be taken as an example only and not to limit the scope of the disclosure.

Those skilled in the art will recognize that analysis **204** by data anomaly detection process **10** may include any combination of attention level **302**, control attention level **304**, difficulty level **306**, actual time **308**, control time **310**, as well as other data. Therefore, any particularly described combination of analyzing **204** attention level **302**, control attention level **304**, difficulty level **306**, actual time **308**, and control time **310** should be taken as an example only and not to limit the scope of the disclosure. Further, while a table is shown in FIG. **3**, this is to help in the explanation of the disclosure, and those skilled in the art will appreciate that any data format or technique may be used to maintain the information of FIG. **3**. As such, the specific format of FIG. **3** should be taken as an example only and not to limit the scope of the disclosure.

Additionally/alternatively, to aid in preventing user **48** from tricking data anomaly detection process **10** (e.g., by using pre-recorded brainwaves and/or the pre-recorded gaze movements and/or other attention detection pre-recordings or by tampering or otherwise disabling the monitoring device), certain protections may be used by data anomaly detection process **10**. Such protections may include but are not limited to, a time system within monitoring device **66**, client electronic device **40** and/or other device cooperatively ensuring proper use and function of all components, and video recording user **48** using monitoring device **66**, where monitoring device **66** or other device may include an appropriate serial number shown on the video or other recording.

Additionally/alternatively, data anomaly detection process **10** may provide feedback to user **48** at the end of performing an action (e.g., informing user **48** which actions are right and wrong and/or giving explanatory feedback when the action is wrong). Notably, a problem may exist in giving such feedback, in that it may overload user **48** with details such that user **48** loses attention. As such, data anomaly detection process **10** may use the same or similar techniques discussed throughout to analyze **204** attention to feedback, and then to increase/decrease the amount of feedback depending on the attention level.

Additionally/alternatively, there may be a mental difference between, e.g., retrieving information from memory and getting information from some other location. For instance, a different mental signature may be produced when user **48** retrieves information from memory to answer a question, as opposed to when user **48** looks up the information in a book. As such, data anomaly detection process **10** may use the same or similar techniques discussed throughout to analyze **204** whether user **48** is retrieving information from memory to answer a question, or retrieving the information from elsewhere. As a result, data anomaly detection process **10** may distinguish between genuine answering of a question from memory and being told the answer after having looked up the answer elsewhere. Therefore, data anomaly detection process **10** may analyze **204** the attention of user **48** to be sure that the exam is really testing what is in the brain of user **48**, not just what user **48** answers.

Those skilled in the art will recognize that while a single user action may analyzed to classify whether a cheating event has occurred, the cheating event may be determined by multiple user actions without departing from the scope of the disclosure. For example, the mind of user **48** may wander occasionally and may or may not be a sufficient indicator of a cheating event. As such, those skilled in the art will appreciate that one or more actions may be analyzed by data anomaly detection process **10** to determine whether a threshold of actions may be classified as a cheating event (e.g., before classifying a cheating event and/or providing an alert of the cheating event). The threshold may be adjusted, e.g., via a user interface in combination with data anomaly detection process **10**, to aid in lessening the risks of a false positive of classifying a cheating event. For example, if three actions are the threshold amount of classified cheating events, then the first two actions that may be normally classified as a cheating event separately as described above may not yet be classified as a cheating event, but may merely be classified as an anomaly by data anomaly detection process **10**; however, if three or more actions that may be classified as a cheating event on their own occur, then one or more of the three or more actions may be classified as a cheating event and not an anomaly. As such, the classification of an action (i.e., a single action) as a cheating event may, but need not, also include the classification of one or more actions as anomalies for at least a portion of an assessment before data anomaly detection process **10** has determined that a threshold of cheating events (or anomalies) have been classified. In the example, data anomaly detection process **10** may wait until the threshold has been reached before providing an alert as noted above. Therefore, the classification of an action (i.e., a single action) as a cheating event should be taken as an example only and not to otherwise limit the scope of the disclosure.

In some implementations, data anomaly detection process **10** may be used for lower stakes quizzes and tests, e.g., where if the person taking the quiz or test is not paying attention, the consequences may be milder, e.g., reminding the person to pay attention. In some implementations, harvesting the evidence that the person was paying attention during the learning and assessment may be useful evidence in regulatory compliance that the person has been through training, since there may be a requirement on companies to prove and document that compliance training has taken place.

While one or more implementations of the present disclosure may be described as classifying **206** an action of the user as a cheating event (e.g., where the attention deficiency event may include a cheating event by the user during an

assessment) using the analyzed attention level of the user, it will be appreciated that the action of the user may be classified **206** as events other than a cheating event without departing from the scope of the present disclosure. For example, in some implementations, as may be equally applicable for the present disclosure, the action of the user may be classified **206** as an attention deficiency event using the analyzed attention level of the user. For instance, in some implementations, the attention deficiency event may include a lack of learning by the user during a learning process. For example, for on screen learning (e.g., e-learning) where learning materials (for example a presentation, a video, some text to read, etc.) is followed by an assessment. In the example, determining **202** and/or analyzing **204** the attention level of the user during the learning process may be useful evidence that the person had followed the learning and may supplement the information from the assessment about their understanding. As such, the description of classifying **206** an action of the user as a cheating event using the analyzed attention level of the user should be taken as an example only and not to limit the scope of the disclosure. Similarly, the description of classifying **206** an action of the user as any type of attention deficiency event may be equally applicable for the present disclosure with tasks other than assessments, such as the above-noted learning process. For instance, classifying **206** that the user is not paying attention during the learning process may cause data anomaly detection process **10** to provide **208** an alert of the attention deficiency event to at least one of the user and a second user, which may result in a change in action, e.g., halting the learning, reminding the user to pay attention, etc. As such, the description of using assessments should be taken as an example only and not to limit the scope of the disclosure.

While the present disclosure may be described using the attribute(s) of gaze and/or brainwaves of user **48**, it will be appreciated that other examples of attributes of user **48** may be used (e.g., identified **200**) by data anomaly detection process **10** to determine **202** and/or analyze **204** the attention level of user **48** without departing from the scope of the disclosure. For example, the at least one attribute may include bodily movement detection. Bodily movement detection may include, e.g., measurement of head, face, jaw, tongue and neck muscle and skeletal movement that may indicate attention, including the 3D movement (e.g., pitch, yaw, and roll) of different parts of the head, including the use of facial muscle activity (e.g., measured by facial electromyography), including measuring changes in the contraction of the corrugator muscle and zygomatic muscle. Similar to gaze detection, it may be possible that if the eyes of user **48** move to look at something, then other parts of the face or head and related areas may also move, which when identified **200** may help data anomaly detection process **10** to determine **202** and/or analyze **204** the attention level of user **48**.

As another example, the at least one attribute may include eye blink detection. The eye blink detection may include, e.g., identifying **200** the duration and frequency of blinks. For instance, assume there may be a correlation between the amounts of blinking and the impact on attention. For example, when user **48** loses attention, user **48** may reduce eye movement and also do less blinking, which when identified **200** may help data anomaly detection process **10** to determine **202** and/or analyze **204** the attention level of user **48**.

As another example, the at least one attribute may include heartbeat rate detection. The heartbeat rate detection may include, e.g., heartbeat rate increase, decrease, rate of acceleration, rate of deceleration, etc. via, e.g., direct measurement and/or via pulse points. For instance, assume there may be a correlation between the heart rate and the impact on attention. For example, when user **48** loses attention, user **48** may have an increased and/or reduced heart rate, which when identified **200** may help data anomaly detection process **10** to determine **202** and/or analyze **204** the attention level of user **48**.

As another example, the at least one attribute may include blood flow velocity. The blood flow velocity may include, e.g., blood flow velocity in the brain (or other locations in the body). In some implementations, blood flow velocity may be measured with, e.g., transcranial Doppler sonography, as well as other devices and/or techniques. For example, when user **48** loses attention, user **48** may have an increased and/or reduced blood flow velocity, which when identified **200** may help data anomaly detection process **10** to determine **202** and/or analyze **204** the attention level of user **48**.

As another example, the at least one attribute may include breathing detection. The breathing detection may include, e.g., breathing frequency, depth of breathing, nature of breathing, etc. For instance, assume there may be a correlation between the characteristics of the breathing and the impact on attention. For example, when user **48** loses attention, user **48** may have an increased and/or reduced breathing rate, which when identified **200** may help data anomaly detection process **10** to determine **202** and/or analyze **204** the attention level of user **48**.

As another example, the at least one attribute may include brain electrical activity detection. The brain electrical activity may include, e.g., brain electrical activity from the frontal, temple, parietal and/or perceptual areas of the brain, as well as other brain electrical activity. For instance, assume there may be a correlation between the characteristics of the brain electrical activity and the impact on attention. For example, when user **48** loses attention, user **48** may have an increased and/or reduced brain electrical activity, which when identified **200** may help data anomaly detection process **10** to determine **202** and/or analyze **204** the attention level of user **48**.

As another example, the at least one attribute may include body posture detection. Body posture may include, e.g., body posture such as slouching, turning to one's side, moving one's head to look away from where a question may be located, etc. (e.g., measured by ultrasound, sonar, echo location, visual means or otherwise) and movements of other parts of body, e.g., hands or feet. For instance, user **48** may be looking at another user or at some other location that may have the right answers, which when identified **200** may help data anomaly detection process **10** to determine **202** and/or analyze **204** the attention level of user **48**.

As yet another example, the at least one attribute may include sweat detection. Sweat detection may include measurements of skin conductance and/or electrodermal activity. For example, when user **48** loses attention, user **48** may have an increased and/or reduced skin conductance (which may also measure physiological arousal that may be a further prediction of attention), which when identified **200** may help data anomaly detection process **10** to determine **202** and/or analyze **204** the attention level of user **48**. As such, the description of using the attributes of gaze and/or brainwaves of user **48** (as well as any other examples of attributes) should be taken as an example only and not to limit the scope of the disclosure.

In some implementations, more than one monitoring device may be used for the monitoring, with the results

correlated together using an attention measurement function. For instance, assume for example purposes only that two monitoring devices are being used by data anomaly detection process **10**. In the example, if the first device measure indicates attention and the second device measure indicates inattention (as discussed above), the conflicting classification **206** of an attention level deficiency event may be less strong an indication of a final classification **206** of an attention level deficiency event than if both indicated inattention. Conversely, if the two or more measures correlate (i.e., they both indicate the same or similar classifications **206**), the correlating classification **206** of an attention level deficiency event may be stronger an indication of a final classification **206** of an attention level deficiency event.

In some implementations, the attention level of the user may be determined **202** with a combination of at least two attributes of the user (e.g., identified **200** using one or more of the above-noted monitoring devices). For example, data anomaly detection process **10** may identify **200** singularly and/or in any combination of attributes of the user (e.g., such as the above-noted attributes), determine **202** an attention level of the user with the identified **200** attributes, analyze **204** the attention level of the user based upon, at least in part, the determined **202** attention level of the user, and classify **206** an action of the user as an attention level deficiency event using the analyzed **204** attention level of the user. For instance, the nature of the attention level measurement is such that a series of different variables that may include a plurality of the above-noted variables may be analyzed **204** singularly and/or in any combination, and may be based on, at least in part, previous sampling of the user, and may then produce a measure of attention combined from a combination of variables. As such, the description of identifying **200** only a single attribute should be taken as an example only and not to limit the scope of the disclosure.

The terminology used herein is for the purpose of describing particular implementations only and is not intended to be limiting of the disclosure. As used herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "comprises" and/or "comprising," when used in this specification, specify the presence of stated features, integers, steps (not necessarily in a particular order), operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps (not necessarily in a particular order), operations, elements, components, and/or groups thereof.

The corresponding structures, materials, acts, and equivalents of all means or step plus function elements in the claims below are intended to include any structure, material, or act for performing the function in combination with other claimed elements as specifically claimed. The description of the present disclosure has been presented for purposes of illustration and description, but is not intended to be exhaustive or limited to the disclosure in the form disclosed. Many modifications, variations, and any combinations thereof will be apparent to those of ordinary skill in the art without departing from the scope and spirit of the disclosure. The implementation(s) were chosen and described in order to best explain the principles of the disclosure and the practical application, and to enable others of ordinary skill in the art to understand the disclosure for various implementation(s) with various modifications and/or any combinations of implementation(s) as are suited to the particular use contemplated.

Having thus described the disclosure of the present application in detail and by reference to implementation(s) thereof, it will be apparent that modifications, variations, and any combinations of implementation(s) (including any modifications, variations, and combinations thereof) are possible without departing from the scope of the disclosure defined in the appended claims.

What is claimed is:

1. A computer-implemented method comprising:

identifying, by at least one computing device of one or more computing devices, at least one attribute of a user;

determining, by at least one computing device of the one or more computing devices, an attention level of the user with the identified at least one attribute;

analyzing, by at least one computing device of the one or more computing devices, the attention level of the user; and

classifying, by at least one computing device of the one or more computing devices, an action of the user as an attention deficiency event using the analyzed attention level of the user, wherein the attention deficiency event includes an indication of possible cheating by the user during an assessment.

2. The computer-implemented method of claim **1** wherein analyzing the attention level of the user includes comparing the attention level of the user with a second attention level, wherein the second attention level is from at least one of the user and a second user.

3. The computer-implemented method of claim **1** wherein analyzing the attention level of the user includes comparing the attention level of the user with a difficulty level of the action of the user.

4. The computer-implemented method of claim **3** wherein analyzing the attention level of the user further includes comparing an amount of time spent by the user to perform the action with the difficulty level of the action.

5. The computer-implemented method of claim **1** wherein analyzing the attention level of the user includes:

identifying the action of the user as requiring the attention level of the user to reach a threshold attention level; and

determining that the attention level of the user is less than the threshold attention level for the action of the user.

6. The computer-implemented method of claim **1** wherein the action of the user includes answering one or more questions.

7. The computer-implemented method of claim **1** further comprising providing an alert of the attention deficiency event to at least one of the user and a second user.

8. The computer-implemented method of claim **1** wherein the at least one attribute includes gaze detection.

9. The computer-implemented method of claim **1** wherein the at least one attribute includes bodily movement detection.

10. The computer-implemented method of claim **1** wherein the at least one attribute includes eye blink detection.

11. The computer-implemented method of claim **1** wherein the at least one attribute includes blood flow velocity.

12. The computer-implemented method of claim **1** wherein the at least one attribute includes heartbeat rate detection.

13. The computer-implemented method of claim **1** wherein the at least one attribute includes breathing detection.

14. The computer-implemented method of claim 1 wherein the at least one attribute includes brain electrical activity detection.

15. The computer-implemented method of claim 1 wherein the at least one attribute includes body posture detection.

16. The computer-implemented method of claim 1 wherein the at least one attribute includes sweat detection.

17. The computer-implemented method of claim 1 wherein the attention level of the user is determined with a combination of at least two attributes of the user.

18. A computer program product residing on a non-transitory computer readable medium having a plurality of instructions stored thereon which, when executed by a processor, cause the processor to perform operations comprising:

identifying at least one attribute of a user;

determining an attention level of the user with the identified at least one attribute;

analyzing the attention level of the user; and

classifying an action of the user as an attention deficiency event using the analyzed attention level of the user, wherein the attention deficiency event includes an indication of possible cheating by the user during an assessment.

19. The computer program product of claim 18 wherein the at least one attribute includes at least one of a gaze detection, a bodily movement detection, an eye blink detection, a blood flow velocity, a heartbeat rate detection, a breathing detection, a brain electrical activity detection, a body posture detection, and a sweat detection.

20. The computer program product of claim 18 wherein the attention level of the user is determined with a combination of at least two attributes of the user.

21. The computer program product of claim 18 wherein analyzing the attention level of the user includes:

identifying the action of the user as requiring the attention level of the user to reach a threshold attention level; and

determining that the attention level of the user is less than the threshold attention level for the action of the user.

22. A computing system including a processor and memory configured to perform operations comprising:

identifying at least one attribute of a user;

determining an attention level of the user with the identified at least one attribute;

analyzing the attention level of the user; and

classifying an action of the user as an attention deficiency event using the analyzed attention level of the user, wherein the attention deficiency event includes an indication of possible cheating by the user during an assessment.

23. The computing system of claim 22 wherein the at least one attribute includes at least one of a gaze detection, a bodily movement detection, an eye blink detection, a blood flow velocity, a heartbeat rate detection, a breathing detection, a brain electrical activity detection, a body posture detection, and a sweat detection.

24. The computing system of claim 22 wherein the attention level of the user is determined with a combination of at least two attributes of the user.

25. The computing system of claim 22 wherein analyzing the attention level of the user includes:

identifying the action of the user as requiring the attention level of the user to reach a threshold attention level; and

determining that the attention level of the user is less than the threshold attention level for the action of the user.

* * * * *